On the phonological nature of the Proto-Indo-European laryngeals

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Introduction.

The presence of so-called laryngeal segments in the Proto-Indo-European phonemic inventory is today widely accepted, but the same cannot be said for any particular theory as to their precise phonological or phonetic qualities. The word *laryngeal* itself is everywhere adopted only as a convenient cover term, stripped of its inherent denotation: use of the term does not commit one to actually believing that the segments lacked supralaryngeal articulation, as it would in ordinary phonological discourse.[1] In response to this absence of a communis opinio, this paper surveys the literature and attempts to justify specific hypotheses.

It would of course be absurd to essay a presentation of a century of argumentation on the evidence for the behaviour of the PIE laryngeals within a paper of this scope. Instead I will have to be content with summarizing and illustrating the hypotheses that I find most plausible and widely accepted. In particular, I shall assume that there are three laryngeals, most easily correlated with their vowel colouring effects.[2] I shall use the (non-IPA) transcriptions most widely employed by Indo-Europeanists, close to those used in Mayrhofer (1986) (but *w, y,* for his *u̯, i̯).* This includes the notations */h_1/ for the non-colouring laryngeal, */h_2/ for the *a*-colouring one, and */h_3/ for the *o*-colouring one, although I personally believe that Saussure was on the right track when he used the more mnemonic symbols /ᴀ/ and /ᴏ̯/ (Saussure 1879).

The first part of this paper will present facts about laryngeals that might have some bearing on their identity, and comment on what they suggest about the phonology of laryngeals within PIE. The later sections will attempt to reconcile conflicting details in putting forth a hypothesis about the identity of the laryngeals and their evolution.

Proto-Indo-European rules.

This section looks at rules and structural constraints that appear to have been operative within PIE itself. A later section will look at daughter-language developments.

Obstruent Voice Assimilation.

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[1] Mayrhofer (1986:5.2n104). One gets the impression from the earlier literature that the terms *laryngeal* and *glottal* were often applied to any suboral articulation. I will attempt to use the word *glottal* in reference to the vocal cords, and *laryngeal*□in reference to the three PIE phonemes under consideration.

[2] See for example Eichner (1988:§1-2) or Mayrhofer (1988) for short arguments for and summaries of this position, with which I am in agreement. There are however a number of prominent monolaryngealists. Bammesberger (1989) for example is representative in feeling that PIE had only one laryngeal; that vowel colouring actually reflects underlying vowel quality distinctions; and that the triple representation in Greek is based by analogy on full grade forms, or is totally random.

In PIE, contiguous obstruents take on the [voice] of the last obstruent in the sequence, and utterance-final obstruents are probably devoiced:[3]

Ad */sed-/ ‘sit’, */ni-sd-ós/ > */nizdós/, hence Skt. *nīḍá-*, Lat. *nīdus*, Lith. *lizdas.*
Ad */ped-/ ‘foot’, zero-grade */pd-/ yielding Avest. *frabdəm* ‘forefoot *acc.*’, Ved. *upabdá-* ‘noise’, ‘stamping?’, Gr. *épibda* ‘day after (*lit.* foot of) a festival’. (Mayrhofer 1986:4.3.1)
Ad */nig^w-/ ‘wash’, */nik^{w}to-/ ‘washed’ > Gr. *ániptos* ‘unwashed’, Old Ir. *necht* ‘clean’ (Mayrhofer 1986:4.10.1)

That is to say, [–son] segments are specified for [voice] only before tautosyllabic sonorants; other obstruents link to the [voice] node of the next obstruent. Spreading happens of course from right to left.

There is evidence that */h_3/—but no other laryngeal—also causes voicing of preceding obstruents (Mayrhofer 1986:5.2.3.4.2):

Ad */peh$_3$-/ ‘drink’ (*/h_3/ because it *o*-colours in Lat. *pōtus),* reduplicating Skt. *píbati,* Old Irish *ibid (imp. pl.)* (Mayrhofer 1986:4.4.2).
*/$h_3$eḱteh$_3$/, ‘eight’, */$h_3$eḱth$_3$wh$_2$ós/ ‘eighth’ > Gr. *oktṓ, ógdoos* (Rix 1976:172, critiqued by Rasmussen 1989:123-130).
*/$h_2$ep-/ ‘water’ + */-$h_3$en/ *Hoffmann suffix*[4] > Celt. *abon* ‘river’ (Hamp 1972).

There is not complete agreement that */h_3/ causes voicing; certainly the number of data points is not overwhelming: the reduplicating */peh$_3$-/ example is the only first-rate piece of evidence. Beekes (1989:25) rejects the idea, although this decision may be influenced by his embracing of the more radical idea that PIE lacked voicing contrast at all, having instead distinctions of pulmonary versus laryngeal airstream—a version of the glottalic hypothesis. If the voicing is accepted, the phenomenon of course strongly suggests that */h_3/ is [–son +voice]. Conversely, the fact that */h_1/ and */h_2/ do not cause voice assimilation suggests that they are [+son]. As sonorants, the assumption would be that they are [+voice] (underspecified, assigned by default), unless glottal (/h/ is universally preferred over /ɦ/, Hock 1991:131).

The effects that obstruents had on preceding laryngeals is less clear. I find no clear evidence that their being present before an obstruent systematically affects their realization in a consistent way across daughter languages. For example, one might expect the */h_3/ in */$h_2$árh$_3$trom/ ‘plough’ to be unvoiced before the */t/, but it shows up in Greek as *árotron,* the normal reflex of */h_3/. These facts are not incompatible: the pattern of evidence suggests merely that the voiceless counterpart of */h_3/ is not identical to any other phoneme. In particular, it is not identical to any other laryngeal. This admittedly small piece of evidence, coupled with the fact that */h_2/ seems not to devoice preceding obstruents, seems therefore to contradict claims often made that */h_2/ and */h_3/ are distinguished only by being respectively [–voice] and [+voice] (Sapir 1938:269, Sturtevant 1942:§9, Bomhard 1979:132-135, who choose [x] and [ɣ]; Couvreur is reported in Sturtevant (1942) to have favoured [ħ] and [ʕ], and so concurs Keiler 1970:68-69).

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[3] Everybody accepts this as a rule of PIE. Obstruent Voice Assimilation is, of course, such a common phenomenon (Hock 1991:65) that it is conceivable that the daughters of PIE all innovated the rule.

[4] A problematic possessive suffix, whose identification is quite controversial. See Mayrhofer (1986:5.2.3.4.2) for a few references.

Syllabication.

Other clues on the sonority of the laryngeals may be found by observing how their presence influences syllabification within a word. PIE contained many segments (*/y, w, m, n, l, r/) which could be found either as consonants or as the nucleus of a syllable, e.g., */b^{h}r̥tós/ ‘carried’. The rule appeared to be that these resonants were made syllabic when found between two non-syllabic segments.[5] If two such resonants appeared between two non-syllabic segments or word boundaries, the second got syllabified:[6]

> */h$_1$lng^{wh}ws/ > *[h$_1$ln̥g^{wh}us] > Gr. *elakhús.*
> */mātrwwyyā/ > *[mātruwiyā] > Gr. *mētruiá* ‘stepmother’ (Mayrhofer 1986:5.2.2.3.2n172).

That is to say, the rule appears to work from right to left (Schindler 1977:56), so as to maximize onsets.

The same rules, however, appear not to apply to laryngeals. Clearly they never prevented the resonants from becoming syllabic, as the well-known example from Saussure (1879:234) illustrates:

> */ǵnh$_1$tós/ becomes Skrt. /jātás/, not */jñitás/.

That is, the reflex is not that expected for interconsonantal */H/, but that expected for syllabic nasals (PIE */m̥, n̥/ > Skt. /a/), lengthened, as are all vowels before laryngeals. This would seem to indicate that the laryngeals were less sonorous than the resonants. Since the resonants include nasals, the least sonorous of the simple resonants (Zec 1988:79-100), the most straightforward explanation would be that they are obstruents, although other explanations are possible. For example, Zec (1988:48) points out that in Kwakw’ala, glottalized sonorants pattern with the obstruents in not making a syllable heavy, which could be explained by their having reduced sonority.

Although an explicit tenet of the laryngeal theory is that Cuny proved once and for all in 1912 that the laryngeals were consonants, many writers assume that, like the resonants, they had syllabic allophones during the PIE period. This is probably the closest possible approximation to the prelaryngealist hypothesis of there being a general PIE */ə/: it is replaced by a laryngeal consonant, but a syllabic consonant all the same. There are some drawbacks to this approach, however. Evidence will be seen in the section on daughter-language developments that vocalization of laryngeals happened differently in different languages. Perhaps the most direct evidence is, as Sturtevant implies (1942:65e), that Hittite has forms to be read as /sanhhzi/, with preservation of original consonantal values in interconsonantal positions. Some languages have vocalic reflexes for initial laryngeal before an obstruent (Hittite, Greek); others, like Latin, have complete deletion, which would be surprising if the vocalization were PIE, since Latin did not ordinarily drop initial vowels. More importantly, there are PIE-internal problems. PIE syllabification would be complicated if one had to assume that two passes were made through the word, first building syllables with sonorants, then building syllables with laryngeals. Furthermore, laryngeals never got the lexical accent, a crucial test for true syllabicity. The facts suggest that laryngeals could not be syllabic, but were of such nature that they could be pronounced between stops and easily developed into vowels in the daughter languages.

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[5] I ignore here other sources of syllabicity, such as Sievers’ Law in its various formulations.

[6] Here too there are exceptions. Most notably, the nasal infix appears never to have been syllabic (Mayrhofer 1986:7.3.3.1): */link^{w}swe/, not **/lyn̥k^{w}swe/. No doubt this infix was added well after the initial syllabification of the lexical entry.

Root structure.

The general template for a PIE root is {s,H}TRVR{H,s}T, where T represents any stop and R any sonorant consonant; all elements are optional (though not all can be absent at the same time!). There are also a few sonorant clusters that can begin a root.[7] And there are to be sure exceptions: there are a few root-initial TT- clusters, some -HR and -TH, but most of these appear to be secondary developments.[8]

There is a long tradition of applying versions of the Sonority Sequencing Generalization to explain PIE root structure constraints. Ammer (1952:209ff) builds on Kurylowicz's work on sonority (1935)[9] to conclude that laryngeals are fricatives: roots of the form -VRH suggest less sonority than resonants, but roots like -VHT suggest more sonority than the stops. Standard discussions of sonority hierarchy (Selkirk 1984, Zec 1988, Hock 1991:22) all agree that fricatives are intermediate between oral stops and sonorants. Watkins (1985) shows about a dozen roots of the form -EsT, affirming that fricatives can indeed appear in this position.

The fact that laryngeals tend to appear before stops in both onsets and codas appears at first to be a sonority paradox. But this is so only if one subscribes to the notion that all template effects are due solely to sonority differences. It seems more likely however that the syllable can tolerate strings of segments with equal sonority, *pace* the normal statement of the Sonority Sequencing Generalization, as in Selkirk (1984:116). Cf. Jespersen (1904:191), who explicitly permits equi-sonorous sequences; and the morification algorithm in Zec (1988:103), where it is required only that a segment in a mora be an extension, not a proper extension, of the preceding segment in terms of sonority (although the informal text appears to say the contrary). Fricatives then may be ordered consistently before stops for some totally different reason: e.g., [+cont –son] may always precede [–cont –son] because stops are less perceptible before fricatives than after them (Hock 1991:126). At any rate, stop-fricative and fricative-stop combinations are both fairly common universally, whereas stop-stop combinations are more marked (Greenberg 1978:254). This suggests at least that the laryngeals are less likely to have been stops.

It might also be interesting to see how laryngeals are affected by other root structure constraints. For example, laryngeals that can be found in the same root as mediae should not themselves be mediae; those found with tenues should not be aspiratae, or vice versa

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[7] E.g., */mreǵ^{h}wih$_{2}$/ 'short' (Lat. *brevis*), */mlewH-/ 'speak' (OAvest. *mraot̰)* (Mayrhofer 1986:6.1.1). Schindler lists as possible onsets /wr/, /mr/, /wl/, /ml, /wy/, /mn/ (Dressler 1972:22). Perhaps the first segment of the word should be considered prosodically circumscribed with respect to the rule of resonant syllabification mentioned earlier.

[8] See Ammer (1952), who finds TEHR sequences particularly rare. Cf. also Lehmann (1952:§14.5) and Penney (1988) for a concise current synopsis. Beekes (1969:188-9) opines that only three or four 'disyllabic' roots are of the form TTH-.

[9] See also Kuryłowicz (1968:437).

(Meillet 1937:173-4; Mayrhofer 1986:4.1.1.2n19). Since in fact there seem to be no such restrictions, one might conclude that laryngeals were not likely to have been stops at all, since these were the only three kinds of stops in Indo-European (Kuryłowicz 1935:46ff):

*/$h_1$ed-/ 'eat' (Watkins 1985 */ed-/), */h_2eǵ-/ 'agere' (Mayrhofer 1986:4.9.3), */deh_3-/ 'give' (Mayrhofer 1986:4.7) ∴ not mediae.
*/d^heh_1-/ 'place' (Mayrhofer 1986:5.2.3.1), */b^heh_2-/ 'speak' (Mayrhofer 1986:5.2.2.2), */h_3eb^hel-/ 'augment' (Watkins 1985 */obhel-/) ∴ not tenues.
*/peh_1-/ 'hurt' (Watkins 1985 *pē-*), */h_2eḱ-/ 'sharp' (Mayrhofer 1986:5.2.2), */peh_3-/ 'drink' (Mayrhofer 1986:4.3) ∴ not aspiratae.

It has also been noted that mediae do not occur in inflectional endings. Since */h_2/ is a common inflectional ending (e.g., perfect */-th_2e/), and */h_1/ appears in the optative morpheme */-yeh_1/ (Mayrhofer 1986:5.2.1.7), this is another argument against their being mediae.

There might have been a further clue, if, as Hoenigswald (1952) has claimed, /sH-/ words were lacking, but others are far from convinced.[10] So the evidence of root structure points to laryngeals as being continuant consonants other than sonorants, apparently fricatives.

Bartholomae's Law.

When a syllable-final voiced aspirate appeared before an obstruent, the entire cluster became a voiced aspirate, as in Skt. *badh-* + *-ta-* > *baddha-* 'bound' (PIE */b^hn̥d^h-/ + */-ta-/) (Mayrhofer 1986:4.10.2.2). Since laryngeals do not have this effect on following obstruents (e.g., */ph_2tēr/ does not develop as if the */t/ were */d^h/), the laryngeals seem not to have been voiced aspirate stops. This also reduces the likelihood that they were aspirate anything, or even /h/ or /ɦ/.

Vowel colouring.

The most clear-cut laryngeal rule in PIE is that */h_2/ changes an adjacent */e/ to */a/, and */h_3/ changes an adjacent */e/ to */o/ (Kuryłowicz 1927a:95). Neither laryngeal affects any other vowel,[11] and */h_1/ has no colouring effects at all.

*/$h_1$es-/ 'be' (Mayrhofer 1986:5.2.1) > Lat. *es-*.
*/reh_1-/ 'riches', Lat. *rēs* (Mayrhofer 1986:5.2.1.1).
*/h_2eḱ-/ 'sharp' > Gr. *ák-ros,* but */h_2ēḱwr/ > Hitt. /hēkur/ 'peak' (Mayrhofer 1986:5.2.2).
*/h_2ēnḱ-/ 'allocate', Hitt. /hēnk-/ (Mayrhofer 1986:5.2.2).
*/$h_2$ówi-/ 'sheep', Lat. *ovis,* Gr. *óïs.* (Mayrhofer 1986:5.2.2.2).
*/h_3ek^wmn/ 'eye', Gr. *ómma* (Mayrhofer 1986:5.2.3).
*/deh_3-/ 'give', Gr. *dídōmi, édōka* (Mayrhofer 1986:5.2.3.1).

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[10] For example, Beekes (1969:82-7) and Lindeman (1987:§95). See also Mayrhofer (1986:5.1.3).

[11] Some scholars argue that */h_2/ colours */o/ to */a/: so Lindeman (1987:§26, §40), citing Kuryłowicz, 'Apophonie', 167ff. I here follow Beekes (1972), who gives at least ten convincing derivations where */o/ is preserved next to */h_3/. All agree that short */e/ is affected; authorities differ as to whether long */ē/ is affected (Lindeman 1987:§46), although I shall follow Eichner (1973)'s finding that it is not.

For */h_1/, this gives primarily negative information as to its place of articulation. While some have taken this "*e*-colouring" to be suggestive of front or palatal(ized) articulation,[12] another useful tack is to consider this indicative of a quite neutral articulation. In particular, if */h_1/ were purely glottal, it would be expected to have no colouring effects.[13] And indeed, most laryngealists have posited a glottal articulation for */h_1/: Sapir (1938:269), Couvreur (cited by Sturtevant 1942:§7), Sturtevant himself (1942:§9), Bomhard (1979:132-5), Colarusso (1988:398) and Beekes (1989:27) all chose [ʔ]; Keiler (1970:68-9) chose [h]; Martinet (1970:217) and Watkins (1990:6.2) favour some sort of glottal; Mayrhofer (1982:184n19) and Rasmussen (1983:377) favour [h], and Møller (cited by Sturtevant 1942:§3b), and Lindeman (1987:§7, §95) find [h] to be a top contender; Normier (1977:183) preferred voiced /ɦ/.

There are two phonologically natural ways to look at the actual colourings. The first is that */h_2/ is lowering and */h_3/ is backing. Under this scenario, */h_2/ lowers */e/ to [æ], and */h_3/ backs */e/ to [ɤ]. Redundancy rules provide that low vowels be back, so [æ] becomes [a], and that back non-low vowels be round, so [ɤ] becomes [o]. The other approach is to consider both */h_2/ and */h_3/ to have backing effect, but with */h_3/ having additional rounding (labialization) (see Martinet 1970:§8.10, 8.26). */h_2/ would then directly give [ɤ], whereas */h_3/ would give [o] (assuming assimilation to both of the articulations). It would not then be surprising that [ɤ] should then migrate to the typologically more natural position for a back unrounded vowel, [ɑ]. One is reminded of how the Early Modern English vowel /ʊ/, after unrounding in the Southern dialects, gradually lowered until the RP vowel was very close to [a].

For these theories to work, one must find for the laryngeals values that are likely to cause colouring: consonants that are likely to back a vowel, and, for the first hypothesis, a value for */h_2/ that is likely to cause lowering. The most obvious explanations are that the laryngeals are themselves [+low] or [+back], and that vowel colouring consists of simple assimilation.

[+low] is normally considered to be a feature of pharyngeal or glottal sounds, see Chomsky (1968:305-307) and Keating (1988:7). This may seem counterintuitive, since neither constricting the pharynx nor producing glottal friction seems to have anything to do with lowering the tongue, but there are examples where the description and grouping seem appropriate. In Masoretic Hebrew, for example, /h/ and the pharyngeals /ħ/ and /ʕ/ all favour the low vowel /a/. When word-final after a long non-low vowel, /a/ is inserted before them:

/gabo:h/, surface [gɑ:βo:ah].
/ru:ħ/, surface [ru:aħ].
/re:ʕ/, surface [re:aʕ].

(surface forms all from Gesenius 1902:§22f). Segholates (underlyingly CVCC words) with these as medial consonants tend to retain and spread original /a/ instead of turning it into /ɛ/ as do other consonants:

/dagl/ surfaces as [dɛɣɛl] (Barkali 1976:§270).

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[12] Møller, cited by Sturtevant (1942:§3b), hypothesized [ʔʲ]; Sweet, cited by Keiler (1970:36-8), chose [ʁʲ]; Lindeman (1987:§7, §95) thought [ç] likely, and Cowgill (1979) uses the notation [x̂]. Beekes (1989:26) counters that palatalized laryngeals or pharyngeals are very rare.

[13] Colarusso (1981:511-512) notes, at least in the case of /ʔ/, that glottals, though often [+low], need not be.

/ʔahb/ surfaces as [ʔahaβ] (Barkali 1976:§286).
/jaʕr/ surfaces as [jaʕar] (Barkali 1976:§285).
/paħd/ surfaces as [paħad] (Barkali 1976:§287).

Smeets (1984:121) reports that Shapsug, a West Circassian dialect, has a vowel /e/ (the more open of the two underlying vowels) that is usually lowered to /æ/ next to "back" consonants, especially /ħ/ and /ʔ/. One may cite other cases where one or the other seems to have lowering effect, but the picture gets very fuzzy when one looks around for languages that lower just adjacent to pharyngeals and/or glottals. Bomhard (1979) argues that pharyngeals cannot have this lowering effect because they do not do so in most Northwest Caucasian languages, and because /ħ/ caused adjacent /a/ to become /ɛ/ at one point in Akkadian. One could also add the fact that certain particles in /a/ change that vowel to /ɛ/ in Masoretic Hebrew before pharyngeals, especially when followed by qameṣ ([ɑ] or [ɔ]) (Gesenius 1902:35h, 100n, 37d). But Keiler (1970) rightly states that the fact that one language happened to have a dissimilation instead of an assimilation hardly disproves that the segment is capable of causing assimilation, but to the contrary shows that it embodies the relevant distinctive feature. Colarusso (1988:393-394) notes that in Gothic, the glottals /h/ and /h^{w}/ cause lowering of high vowels, but so does /r/. Bomhard (1984:14-15), citing Colarusso (1975:396), states that /h/ (but not /ħ/) in Ubykh and Circassian lowers vowels. Kuipers (1960:22-23) perceived a lowering in Kabardian next to pharyngeals, but Colarusso (1988:299, 336-345) explicitly refutes this, stating that pharyngeals have backing, not lowering effect in the Northwest Caucasian languages. The picture is further confounded by the fact that other cases of consonants changing /e/ to /a/ have to be factored out as backing effects, which will be discussed shortly. One cannot avoid the conclusion that the phonology of segments past the velar region is not well understood.

I suspect the problem may come from attempting to make do with at least one too few phonological features to describe all the complicated gestures that can occur in this region. The arguments of Colarusso (1981, 1988) that pharyngeal does not necessarily imply [+low] in Northwest Caucasian languages appear convincing: he finds that glottals generally lower vowels, but pharyngeals do so only in a few languages, such as in some of the Abaza dialects (1988:394-398, where he concludes that */h$_2$/ was just such a segment, viz., */ħ^{h}/). Indeed, there does not seem to be any anatomical reason why constricting the pharynx should necessitate a significant lowering of the dorsum. If one adopts the feature [constricted pharynx] (Keating 1988:7; henceforth [CP]), matters become somewhat clearer. [+low] can be used for situations where there really is a lowering of the dorsum in the buccal cavity. One then sees there are several possibilities that can freely combine and are indeed attested:

[+low +CP]	Low pharyngeals as in Hebrew, Abaza.
[–low +CP]	Non-low pharyngeals as in most Northwest Caucasian.
[+low –CP]	Low glottal fricatives [h] as in Hebrew, imparting vowel colour.
[–low –CP]	Non-low [h] as in English, taking on the colour of the adjacent vowel.

Thus one does not expect [+low] to necessarily imply either pharyngeal or purely glottal articulation, or vice versa, but there is clearly a connection. If a consonant is [+low], other dorsal articulations are probably ruled out, and indeed all lingual articulations are probably disfavoured, but pharynx constriction or purely glottal articulation would be an easy concomitant. Conversely, if a consonant is [+CP] or a glottal fricative, opening up the oral cavity with a [+low] gesture probably increases the sonority of the low-amplitude friction, and so is probably a favoured concomitant gesture in many languages. There might also be a tendency in [+low +CP] languages to press the root of the tongue against the pharynx, rather than relying totally on pharyngeal constriction; this may well correspond to the feature [+back].[14]

In short, then, if */h_2/ was distinctively [+low], this would seem to mean that it was pharyngeal or glottal, which is not far from where SPE left us. The theoretical distinction between [+low] and [+CP] will be important later, however, and for the time being lets one skip the argument as to whether pharyngeals *tout court* do or do not lower. Furthermore, it explains why /h/ is /a/-like in some languages but neutral in others, without resorting to devices like that of Colarusso (1988:404), who correlates the former with consonant-dominated languages and the latter with vowel-dominated languages, to which class English apparently belongs.

One would not expect the pharyngeal hypothesis to be easy to come to, since pharyngeals are so unfamiliar to most Europeans and their properties not well understood; nevertheless the pharyngeal hypothesis was developed as early as Møller, and was continued by Couvreur (both cited by Sturtevant 1942), Martinet (1970:217), Keiler (1970:68-9), Mayrhofer (1982:184n19) and Beekes (1989:27), and Lindeman (1987) is also attracted to the idea. I do not however know of any proposals that */h_2/ was distinctively glottal, except that some who oppose */h_2/ to a separate */h_4/ (lost in Anatolian) sometimes hypothesize */h/ for the latter (Sturtevant, Colarusso, and Lehmann 1952:108, all cited by Bomhard 1984:12-14).

The second scenario was to posit backing effect for both laryngeals, distinguishing them by additional rounding in the case of */h_3/. The feature [back] is somewhat better understood: any segment that is articulated beyond the hard palate, or that is velarized or pharyngealized, is [+back]; pure glottal sounds are normally excluded (Chomsky 1968:307). This is the approach taken by laryngealists such as Sweet (cited by Keiler 1970:36-8), Sapir (1938:269), Sturtevant (1942:§9) Lehmann (1952:14.8), Miller (cited by Mayrhofer 1986:5.2n103), Normier (1977:183), Bomhard (1979:132-5), Cowgill (1979:29), Rasmussen (1983:375), and Watkins (1990:6.2). Colarusso 1988:299, 336-345 is adamant that pharyngeals have backing effect in the Northwest Caucasian languages. In Shuswap, an Interior Salish language (Pacific Northwest) described by Kuipers (1974:26), uvular consonants, and especially the pharyngealized uvular resonants, change adjacent /e/ to /a/ (pronounced [æ] or [a]). In early Latin, /e/ changed to /o/ before /w/ or after /Cw/ (including *qu),* or before a velar /ł/ (Buck 1933:§80). In Arabic, the vowel fatḥa is typically pronounced [a] next to a pharyngeal or velar, [ɔ] next to an emphatic (velarized/pharyngealized) consonant, otherwise [æ] or [ɛ].[15] Smeets (1984:121) reports that Shapsug /e/ is rounded and retracted to /o/ next to most labialized consonants. Hock (1991:141-2) takes a more acoustic approach to vowel colouring. In his opinion, [+grave] segments favour rounding and backing, while [–grave] ones favour fronting. For example, in Danish, short /a/ has a front pronunciation before coronal consonants, and a back pronunciation before grave consonants (Norlev 1973). Hock gives only two examples, both from Pali, so it is difficult to evaluate this generalization; at any rate, [+back] consonants are all probably grave (Keating 1988:4), so any [+back] consonant would conform to his generalization. Hock also points out that retroflex consonants often have a backing effect, citing American vowels before /r/.

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[14] J. McCarthy wrote an interesting paper on the subject, called “Guttural phonology”, and M. Halle wrote a paper on “The intrinsic structure of speech sounds”, which is reported to have some interesting speculations about pharyngeals. These papers also have in common the fact that they were written in 1989, were not published, and were not available to me while writing this paper.

[15] Wright (1896:§5), Haywood (1965:§4). Keiler (1970) also gives a good account of the Arabic facts.

One problem when discussing rounding effects is that PIE had an independent */w/ and a series of labiovelar stops, none of which caused rounding. Somewhat surprisingly, however, I know of no laryngealists who have posited a distinctive primary place of articulation for */h_3/, except for Mayrhofer (1982:184n19), who favours a velar consonant over against glottal */h_2/, and Watkins (1990:6.2), who speculated on a pharyngeal */h_3/ over against a velar */h_2/. Sweet, Lehmann, Martinet, Lindeman, Beekes, Cowgill, Colarusso, Normier, Rasmussen, and Watkins all favoured the idea that */h_3/'s colouring properties were caused by labialization.

Nor did any of the velar stops in PIE cause backing. On the other hand, Hock notes that /x/ is particularly likely to colour vowels; conceivably continuants have a stronger colouring effect than stops. The other possibility is that the laryngeals were more back than the velars, therefore having a stronger attraction. Once an */e/ is backed to /ɤ/, it seems reasonable that as a back vowel it would then be more likely to pick up on any rounding effect */h_3/ might have had, even if */e/ itself was generally immune to labialization. There is also the possibility that */h_2/ was both [+low] and [+back], with each gesture contributing to the assimilation of */e/ to */a/.

One might note in passing Bomhard (1979)'s thesis that pre-PIE had a more typologically normal vowel triad */i/, */a/, */u/; added the precursor of */o/ by apophony; then introduced */e/ by fronting most */a/. The */a/ next to */h_2/ would have been prevented from fronting due to the back articulation of the consonant, a phenomenon common in Semitic, where for example the Hebrew segholates mentioned above have original /a/, and the Arabic fatḥa colourings are actually frontings of /a/ blocked by back segments. Theories of */h_2/ as a back consonant would work equally well for this theory as it would for the change */e/ > /a/, but theories of */h_2/ as a low consonant would be essentially irrelevant to the prevention of an */a/ > /e/ change, which must be seen as a fronting. Of course, low consonants are normally back, so this is not as decisive an argument as it could be, and the argument has no weight at all if we assume with the vast majority that the direction of change was /e/ > /a/.

Finally, it might be useful to consider why only */e/ is affected by vowel colouring. The scope of the problem depends on one's opinion as to the PIE vowel system. An argument can be made that it had a Latin-like system, with five qualities and two quantities. An argument can also be made that it had only one vowel underlyingly, the rest being introduced by laryngeal colouring, glide syllabication, morphological lengthening and apophony (*/e/ > */o/), and late borrowings, onomatopoeia, etc. If one only has to account for */e/, then there is no problem at all. If only */e/ and */o/, then the only issue is why */h_2/ does not colour */o/. Under the [+back] theory, there is again no problem, since */o/ is already a back vowel; under the [+low] theory, it might be that it indeed lowers it to [ɒ], but that [+low +round] being unnatural, the vowel gives up [+low] and therefore merges back to [o].[16] Even if one accepts more vowels, one may hypothesize that colouring began as a postlexical rule when pre-PIE was a simpler one- or two-vowel system; Lindeman (1982) even suggests that it predated apophony. But I think the simplest approach would be to recognize */e/ as a completely unmarked vowel, totally lacking a Dorsal place node; this corresponds to Martinet (1970:217n15)'s suggestion that it was a vaguely central, middle vowel that originally was permitted a widely varying range of articulation. It would therefore be uniquely positioned to pick up the Dorsal node from an adjacent low or back consonant. Long vowels may have been protected by their tenseness. One might compare the description of Squamish in Kuipers (1967:§27, §74-5). It possesses three stable vowels /i/, /u/, /a/, plus a morphologically 'default' vowel which Kuipers transcribes as /ə/ and describes as ranging over the values [ɪ], [e], [ɛ], [ö], [æ], [ɑ], [ʌ], and [ɔ], depending on the surrounding consonants. A similar situation obtains in the Northwest Caucasian languages, which generally have only two underlying vowels (Colarusso 1988:295-312). The surface long vowels, which appear to derive from underlying VC sequences, have much less contextual variation than the short vowels (Colarusso 1988:312-331).

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[16] Watkins (1965:118-122) states that Meillet's assumption that the Baltic distinction /ā/ vs /ō/ represents such a distinction is largely illusory. Besides, that assumption held that /oh_3/ gives /ō/ and that the Baltic /ā/ is from apophonic /ō/, the exact opposite of the evidence this lowering hypothesis would require.

Metathesis.

After a consonant, a sequence of any laryngeal plus high vowel is metathesized. See Hammerich (1948:§15). Watkins (1990:6.2.5.2) says this is merely a tendency, triggered by *e*-deletion in zero grades. Connolly (1989) suggests that the metathesis is peculiar to Indo-Iranian. Lindeman (1987:52-4) finds the data uncertain. Of course, metathesis is normally expected to be a sporadic process with many exceptions (Hock 1991:110).

*/ph$_3$itó-/ > Skt. *pītá-* 'drink' (Beekes 1988:64).
*/pHur/ > Gr. *pûr* 'fire' (Beekes 1988:73).

Ultan (1978:375) points out that metathesis is disproportionately common with liquids; indeed, one is reminded of the early English metathesis, which accounts for modern English *bird, first, third* from OE *bridd, frist, þridde,* and similar developments throughout Slavic. This would therefore be a piece of evidence suggesting that the laryngeals might be liquids. Sibilants are the next most frequent metathesizers (Hock 1991:130), but this seems to be limited to interchanges with stops. One might also note that a similar metathesis occurs in the Anatolian dialect of Abkhaz (Dumézil, cited by Colarusso 1988:180-181), where in verbal indexes, glides, including /h/, may switch places with the following vowel: /w-ha-ba-wt'/ > /wahbawt'/.

It might be useful to note in this connection that the sequence */w/ plus syllabic resonant is also subject to metathesis in PIE (Mayrhofer 1986:7.3.1), producing a nonsyllabic resonant plus /u/:

*/k^{w}etwr-/, Avest. *čaθru-,* Gall. *petru-* (Mayrhofer 1986:7.3.1)

Since */u/ is more sonorous than the liquids and nasals, this would seem to be an attempt to change to a more natural sonority gradient. It is difficult to see a direct parallel with the laryngeal case. It might be noted, however, that CHV- is a disfavoured syllable type, as shown by root constraints. Ultan (1978:373) argues that regular metathesis is fundamentally a conservative process, which arises in order to preserve favoured phonological patterns. It is possible that this problem was more strongly felt for */i/ and */u/ than for the more sonorous full vowels, which would have a steeper sonority gradient. If that is the explanation, however, then it is difficult to see why the even less sonorous syllabic liquids and nasals were not affected (although it is not completely certain that they were not).

Structural considerations.

All things being equal, there is some appeal to picking reconstructions that leave, or, better, introduce a structural balance. Since there are three laryngeals, there is a temptation to fit them in with other features that come in threes in PIE. They could for example be fricatives corresponding to the three dorsal articulations, perhaps /x́/, /x/, and /x^{w}/. This is Cowgill's approach (1979:29), and Lindeman (1987:§95) finds it "tempting," and throws in voiced counterparts for good measure; he quotes Allen's description of Abaza as proving that such a system is possible. Or since all stops have three laryngeal (in the proper sense) distinctions, perhaps they are the three stops from a lost place of articulation, such as /q/, /ɢ/, and /ɢ^{h}/.[17]

Another temptation would be to select values that would make PIE more typologically normal. Maybe one of the laryngeals is the missing /b/—perhaps */h$_{1}$/, which seems to be neither low nor back, could be /b/ or a weakened form of it.[18] A strong typologist might even be tempted to call the laryngeals the missing voiceless aspiratae (the PIE system /t/, /d/, /d^{h}/ being quite rare, though not unheard of). Or, if resigned to introducing fricatives, one might at least wish to consult universalist studies, and attempt to introduce /f/ or /ʃ/ before introducing velar, or, especially, pharyngeal, fricatives (Nartey 1979:4, 6).

These ideas are interesting, but clearly a sound methodology requires us to make typological statistics one of our last considerations, to be invoked only to break ties when other considerations leave us with two or more candidates.

Other effects.

Lindeman (1987:§55-7) believes that some intervocalic /-yH-/ and /-Hy-/ sequences may have undergone assimilation to /-yy-/, which process he works into a theory that some of the laryngeals were palatal fricatives. Unfortunately, the conditions for this rule, if it is a rule, have not been worked out satisfactorily, so this data point should be taken with a grain of salt. Suggestions that other sonorants are subject to the assimilation[19] seem even less certain, or postdate the protolanguage.

Saussure discovered a rule whereby a laryngeal outside a resonant is deleted in a syllable in the *o*-grade. This is rather surprising, and it is hard to know what to make of such a process. The only imaginative explanation I have encountered is that of Rasmussen (1989:145-230), who adduces this fact in support of his idea that the *o*-grade is in part the result of an older consonantal infix, which was approximately /ʀ/, a uvular fricative or approximant like the Danish *r*. Laryngeals in a cluster like /HRʀC-/ or /CʀRH-/ would have disappeared in an effort to make the difficult consonant cluster more pronounceable. Whether or not Rasmussen's thesis is correct, it would seem clear that the phenomenon must have something to do with the inherent sonority, or rather, strength, of the laryngeals as a class, and therefore serves to do no more than corroborate their tendency to be lost. The quality of the *o* vowel per se is probably irrelevant (except insofar as it can be correlated with sonority in some way, as Rasmussen does), since the rule affects all of the laryngeals, regardless of their own quality.

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[17] I have only heard this particular proposal orally from Andrew Garrett, who heard it from Schindler, but both rejected the idea.

[18] I actually do not see any merit in this idea either. After all, as Mayrhofer (1986:4.4) states, "Die Media */b/ ist selten, aber sie ist nicht abwesend." To make this work, one would have to find secondary originals for all existing */b/.

[19] Lindeman (1987:§58-9) cites Seebold on some Old Icelandic /nn/, Lühr on Germanic, and Watkins, Jasanoff, and Melchert for Hittite.

Developments in daughter languages.

In the following I attempt to abstract out the developments that seem most relevant to identifying the phonemic nature of the laryngeals within PIE. See Beekes (1988) for a more comprehensive survey.

Consonantal reflexes.

Anatolian.

*/h_1/ is generally reported as being deleted in Anatolian (Kuryłowicz 1927a:104), although Benveniste (1935:149) and others assert that initial */h_1/ became /a/ before a consonant:

*/$h_1$sénti/ 'they are' > Hitt. *asanzi* (Mayrhofer 1986:5.2.1.2).

*/h_2/ survives almost everywhere (Kuryłowicz 1927a:101). In Hittite it is written by the symbols standardly transcribed as <ḫḫ> where orthographically possible (i.e., intervocalically), but as single <ḫ> elsewhere or when lenited.[20] Reflexes also show up in Luvian (spelt <ḫ> in Cuneiform Luvian) and in Lycian (<χ, q>, leniting to <g>).[21] Lindeman (1982:§1) also claims that /h_2/ survives in Palaic as <ḫ(ḫ)>, refuting claims by Watkins (1975:362) that it shows up as <g>.

*/peh$_2$ur/ 'fire' > Hitt. *paḫḫur* (cf. */ph$_2$ur/ > */puh$_2$r/ > Gr. pûr).
*/$h_2$erǵ-/ 'white' > Hitt. *ḫarki* (cf. Gr. *argós*).
*/$h_2$éwh$_2$o-/ 'grandfather' > Hitt. *ḫuḫḫas* (Beekes 1988:81), Lyc. *xuga-* (Garrett; cf. Lat. *avus*).
*/$h_2$ówi-/ 'sheep' > Cun. Luv. *ḫawi-* (Beekes 1988:81), Lyc. *xawã* (acc.) (Garrett).

*/h_3/ is less certain; it appears to survive only in some positions, and not in all languages, e.g., Lycian lost */h_3/ word-initially. Eichner (1978:162n77) insists that it was always deleted in Anatolian. Others believe that it usually disappeared unless devoiced by a following voiceless obstruent (Mayrhofer 1986:5.2.3.4.1). It is always spelt with a single <ḫ> in Hittite, and is spelt <g> in Lycian (but cf. Watkins 1990:6.2.4).

*/$h_3$ep-/ 'wealth' > Hitt. *ḫapp-inant* (cf. Lat. *opus).*
*/$h_3$pus-/ > Hitt. *ḫa-a-pu-ú-š* 'penis' (cf. Gr. *opuíō* 'marry') (Mayrhofer 1986:5.2.3.4.1n182)
*/$h_1$neh$_3$men-/ 'name' > Hitt. /lāman-/ (Mayrhofer 1986:5.2.3.4.1).

Of course, exactly what sound it might be that those graphemes represent is itself a matter of contention. Since in Hittite doubled obstruent graphemes correspond to voiceless (or fortis) sounds and single ones to voiced (or lenis) sounds (Sturtevant's Law, Sturtevant 1951:§53), this evidence suggests that the reflex of */h_2/ was voiceless (except where lenited) and the reflex of /h_3/ was voiced. The sounds also seem to be sufficiently related to be representable by the same symbol in Hittite, and */h_3/ is identifiable with the lenited form of */h_2/ in both Hittite and Lycian. Now the Hittite symbol transcribed as <ḫ> comes ultimately from Old Akkadian as used in Northern Mesopotamia, where it probably represented a voiceless velar fricative, or indirectly via Hurrian, where the Ugaritic transcriptions make it fairly clear that <ḫ> was [x] when doubled, [ɣ] when single,[22] but of course Hittite may simply have made do with the single 'guttural' continuant grapheme available in the script, even if its pronunciation in the source language was not identical. (By 2000 BCE, Akkadian had merged /ʔ/, /h/, /ħ/, /ʕ/, and /ɣ/ into one sound /ʔ/, leaving only /x/ for a guttural fricative; Ungnad 1964:§4.) The Lycian symbol <χ> for */h_2/ represents Greek χ (but Greek transcriptions of Anatolian laryngeals often use κ or nothing), and its <g> for */h_3/ corresponds to γ. All of these symbols would most conveniently represent a velar or uvular fricative, although Colarusso (1981:541) points out that these could also be *faute de mieux* renderings for pharyngeals. It is also noteworthy that Anatolian borrowings into Armenian have *x,* a voiceless velar fricative (Greppin 1988:188-190). The pattern of deletions also suggests that */h_2/ was stronger (more fortis) than */h_3/, and both were stronger (less easily deleted) than */h_1/.

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[20] Eichner (1973:100n88). The Anatolian lenitions affected consonants after a stressed long vowel or between two unstressed vowels (Eichner 1988:145).

[21] Lindeman (1987:§21), citing Laroche, *Dictionnaire,* 18 and Laroche *BSL,* p. 60. See also Eichner (1988:§4).

Non-Anatolian.

The question as to whether laryngeals survive as consonants in non-Anatolian languages is much more open. Martinet (1970:§8.11-23) claims that some */h_3/ often developed into ("exuded") a /w/ intervocalically. He adduces this /w/ as evidence that the laryngeal was labialized, although as Crossland (1958:90-92) points out, the /w/ can also be accounted for by the presence of the rounded vowel /o/ produced by */h_3/ vowel-colouring.

There have also been some claims that some laryngeals may have become velar stops (Lindeman 1987:§78-83). One of the more plausible[23] of such hypotheses is Martinet's claim[24] that laryngeals, primarily */h_2/, may have become /k/ before /s/ in some daughter languages:

> Lat. nom. *senex,* gen. *senis* 'old', would be explained as hysterokinetic PIE */$seneh_2s$, $senh_2es$/.
> Cf. Lat *genetrīx* : Skt. *janitrī.*

Note however the lack of *a*-colouring and lengthening in *senex;* Colarusso (1981:545) stresses that the laryngeal has *become* a velar stop in this dialect in this environment, losing its laryngeal colouring ability; this is not evidence that the laryngeal *was* a velar stop in general. Martinet points out a change in Germanic languages such as English, where /x/ becomes /k/ before /s/ *(six, fox),* suggesting */h_2/ was /x/. The theory is occasionally, though much less convincingly, extended to explain the alternation of word-initial /k/ with zero.[25] If accepted, all of these developments would seem to be evidence that */h_2/ was in most environments a fricative with approximately velar pronunciation.

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[22] Puhvel (1965:80-86); Kronasser (1966: 94-100). Lindeman (1987:§89) also refers to several authorities cumulatively suggesting a dorsal fricative or velar plosive pronunciation for the Hittite laryngeals.

[23] But contrast Beekes (1969:4): "Development to *k* or *r* is assumed by only a few and can safely be left out of consideration."

[24] Polomé (1965:34) cites Martinet, 'Couple senex-senatus.'

Claims have been made that some initial /h-/ in Albanian derive from */h_2/ (Hamp 1965), and that in Armenian, */h_2/ and perhaps */h_3/ develop like */k/ and */k^w/, e.g., into initial /h-/ (Winter 1965a), but perhaps only before */e/ (Beekes 1988:76, 101); see also Greppin (1988:183-185).

*/$h_2$ew-/ 'grandfather' > Arm. *haw* (Lat. *avus,* Hitt. *huhhas)* (Greppin 1988:184).
*/$h_2$elsno-/ 'alder' > Alb. *halë,* Lat. *alnus* (Beekes 1988:101).
*/$h_3$ewi-/ 'sheep' > Arm. *hoviw* 'shepherd' (Lat. *ovis*) (Greppin 1988:184).

Vocalic reflexes.

Despite these clever claims, outside of the Anatolian languages the most prolific convincing reflexes of the PIE laryngeals are vowels. Vocalic reflexes turn up mostly between consonants, though in some languages they are also found word-marginally next to a consonant.

Schwa.

In most languages, interconsonantal schwas all show up as /a/. In Indo-Iranian, this is /i/ or /ī/[26]; in Balto-Slavic, it is generally deleted (Beekes 1988:89). This equation is the traditional Indo-European schwa. Word-marginal laryngeals are ultimately deleted in these languages.

*/$h_1$er$h_1$ter-/ 'rower' > Skt. *aritár-* (Beekes 1988:62).
*/sh_2t-/ 'satisfied' > Lat. *satis,* Goth. *saþs* (Beekes 1988:96).
*/deh_3-/ 'give', */dh_3-to-/ 'given' > Skt. *ditá-,* Lat. *datus.*

Of itself, this development does not reveal very much about the laryngeals. On the one hand, it may mean that they were so sonorous that they developed into vowels; on the other, it could mean that they were so difficult to pronounce in clusters that they developed an epenthetic vowel. /a/ of course is a rather unusual choice for an epenthetic vowel; the traditional account is that an */ə/ was inserted, which developed into an /i/ in Indo-Iranian but /a/ elsewhere. Another possibility is that only the Indo-Iranian /i/ is an epenthetic vowel; the variation between long and short /i/ would depend on whether it was in a particular environment inserted before or after the laryngeal (see the section on Compensatory Lengthening, below). The other languages may have developed /a/ as a direct vocalization of the laryngeals (or rather, of some single segment into which all the laryngeals had merged).

The triple representation.

Greek, as well as Armenian (word-initially) and perhaps Tocharian and Phrygian, have different reflexes for the three laryngeals when the PIE laryngeal was not next to a vowel:

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[25] See Rousseau (1990) for a discussion and an alternative explanation.

[26] Jamison (1988) argues that the long vowel arose by sound change before a word-final consonant, and analogically in some other situations.

*/h$_1$/ became /e/, */h$_2$/ became /a/, and, in Greek, */h$_3$/ became /o/ (Armenian /a/, which is a regular development of */o/).[27]

*/h$_1$new-/ 'nine' > Gr. *ennéa,* Arm. *inn,* but Lat. *novem* (Greppin 1988:182).
*/h$_1$rudhros/ 'red' > Gr. *eruthrós,* but Lat. *ruber* (Beekes 1988:70).
*/h$_2$nēr/ 'man' > Gr. *anḗr,* Arm. *ayr* (Greppin 1988:181), Phryg. *anar* (Mayrhofer 1986:5.2.2.1), but Skt. *nar-a* (cf. *sūnára-,* 'bountiful', *viśvā́nara-,* where a marginal laryngeal would explain the lengthening).
*/h$_2$stér/ 'star' > Gr. *astḗr,* Arm. *astł* (Greppin 1988:181), but Hitt. <ḫa-aš-te-er-za> (Mayrhofer 1986:5.2.2.1), presumably /xsterts/.
*/h$_3$neh$_3$mn/ 'name' > Gr. *ónoma,* Arm. *anun* (Greppin 1988:182), OPhr. *onoman* (Beekes 1988:75-6, 105).

By Rix's Law, this also obtained when an initial laryngeal was followed by a liquid or nasal resonant that was syllabic in PIE (Rix 1970), and the same happens to final laryngeals after these sounds.[28]

*/h$_1$rsḱe-/ > Gr. *érkhomai* 'go', but Skt. *ṛccháti.* (Mayrhofer 1986:5.2.1.5B after Rix 1970).
*/h$_1$rg^{w}ont-/ 'black' > Toch. A*arkant,* B*erkent* (Beekes 1988:86).
*/h$_2$rǵró-/ 'shining' > Gr. **argrós* > *argós,* but Ved. *ṛjrá-,* Hitt. /harki-/ 'white' (Mayrhofer 1986:5.2.2.6); */h$_2$rǵnt-/ > Arm. *arcat'* 'silver' (Beekes 1988:77).
*/h$_3$ek^{w}ih$_1$/ 'eyes' > Gr. *ósse,* but OCS *oči,* Lith. *akì* (Klein 1988:264).
*/-ih$_2$/ fem. > Toch. B *-ya*, e.g., *rtarya* 'red' (Beekes 1988:86), Gr. *-ya* (Klein 1988:265).
*/h$_3$rǵh-/ > Arm. *orjik'* 'testicles' (Beekes 1988:77).

Similar effects occur when the laryngeal is preceded by a syllabic sonorant: in Greek, for example, typical unaccented[29] R̥H developments before C are Rē, Rā (Attic Rē), Rō (Beekes 1969:266, Mayrhofer 1986:5.2.1.4):

*/ǵnh$_1$tó-/ > Gr. *gnētós* 'born' (Mayrhofer 1986:5.2.1.4).
*/ḱrh$_2$tó-/ > Gr. *ákrātos* 'unadulterated' (Mayrhofer 1986:5.2.2.6).
*/ǵ^{h}lh$_3$ró-/ > Gr. *khlōrós* 'green' (Mayrhofer 1986:5.2.3.5).

This threefold reflex is one of the strongest direct clues as to the quality of the laryngeals. */e/ suggests a front or at least non-back (perhaps glottal) pronunciation for */h$_1$/. */a/ suggests a low or at least back pronunciation for */h$_2$/, and */o/ suggests a back, perhaps rounded pronunciation for */h$_3$/. This of course is the same as the evidence from vowel colouring.

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[27] Kuryłowicz (1927b). Lindeman (1982:§4), with Kuryłowicz, disputes the triple representation but agrees (§5) that some "prothetic" vowels are from laryngeals. Beekes (1969) defends the theory for Greek and Armenian, and, on p. 20-21, discusses the Phrygian evidence. See Winter (1965b:201-206) for Tocharian. Greppin (1988) gives a good current account for Armenian and a review of the literature, and Sihler (1988) does the same for Greek.

[28] Beekes (1988:74) hints that initial RH- vocalized the laryngeal as well. Ringe (1988:429-433) claims an application in Latin: */n̥/ > /in/; */h$_2$n̥/ > /an/; */h$_3$n̥/ > /un/. Rasmussen (1990b) believes that final */h$_1$/ does not become /e/ in this environment, but disappears with compensatory lengthening in Greek, Armenian and Tocharian.

[29] The forms /eRe, aRa, oRo/ turn up too, and the difference may be related to accent; see Mayrhofer (1986:5.2.1.4.1), Beekes (1988:74).

Again, one might reasonably wonder whether the laryngeals turned directly into vowels, or whether they first spawned an epenthetic vowel, then disappeared. Consonants turning into vowels are not unusual; within IE itself one sees for example vocalic reflexes for many of the resonants: /y/ and /w/ often end up as /i/ and /u/, and even the relatively unsonorous nasals vocalize: /n̥/ ends up as /a/ in both Indo-Iranian and Greek. I do not know of this being the immediate fate of any obstruents, however. Pharyngeal continuants do seem to be liable to vocalization. This may tie in with Halle's reported finding that pharyngeals are always glides. In my experience the waveform of an Arabic /ʕ/ certainly has the periodic shape of a vowel, though with reduced amplitude. For comparative evidence, note Kuiper's description of Shuswap (Kuiper 1974:24): "The glides γ, γ' are comparable to voiced prevelar fricatives but are pronounced with a very wide aperture. ʕ is close to a voiced uvular fricative or to a weak uvular trill, again with a wide aperture; it sounds somewhat like a pharyngalized back [a], except in the surroundings é-C, é-# (# = word-end), where the combination eʕ sounds as long [aː]. In the same way, ʕᵒ sounds like a pharyngalized [ɔ], except in the surroundings ú-C, ú-#, where [ɔː] results.... In vocalic positions γ has the timbre ə, ʕ the timbre [a] and ʕᵒ the timbre [ɔ], all three with a slight velarization resp. pharyngalization..." In several Circassian languages, it appears that some /a/ derives from earlier /ʕ/, apparently via /ɦ/ (Colarusso 1988:181-184, 312-329).

So the simplest account is that the laryngeals turned into the qualitatively nearest vowels. This accounts directly for the reflexes of laryngeals between consonants and word-marginally next to consonants. It also seems to be the best account for Rix's Law: the laryngeals must have increased in sonority until they were more sonorous than the resonants, bringing the language to the point where in HRC- clusters the H was made syllabic instead of the R. That is to say, at this stage they must have been basically (voiced) glides. Even if one does not believe the laryngeals were glides in PIE, they may well have been so by this time, since Hock (1991) indicates that glides are a common enough step in a historical lenition process. Simultaneously with Rix's Law, these would have been reanalyzed interconsonantally and made syllable nuclei there too. Next to a full vowel, however, the laryngeal disappeared entirely, perhaps because of an insufficient sonority gradient: one notes that glides in general are lost in Greek, at least in Attic. It is worthy of note that in the context VHC the vowel always lengthened, suggesting compensatory lengthening, i.e., that the H was always in the coda in this environment. The PIE root structure has already shown that laryngeals preferred not to introduce onset clusters.

It should be mentioned however that many linguists see the Greek process as an epenthesis.[30] Preconsonantal laryngeals word-initially or after a consonant would insert a supporting vowel to their right (which position avoids compensatory lengthening); next to a resonant, however, the vowel would always appear to the right of the resonant. Vowel colouring then compensatory lengthening would account for the reflexes. This account is not unreasonable. But it does require us to believe that the laryngeals retained in pre-Greek exactly the same colouring rules that PIE had. And there would seem to be two separate principles involved in the epenthesis. The insertion of a vowel next to a consonant would seem to have taken place because the laryngeal was being evicted from consonant clusters. But the regular insertion in the middle of /HR/ and /RH/ sequences seems more like svarabhakti. It is rather a coincidence that the svarabhakti applies only to resonants next to a laryngeal. Mayrhofer (1986:5.2.1.2) is also in favour of this anaptyxis hypothesis. For comparative evidence, Lindeman (1987:§84) points to the vowel that breaks up pharyngeal plus consonant clusters in Masoretic Hebrew, e.g., /jɛ̀ħɛzáq/ as a beiform of /jɛ̀ħzáq/ (Gesenius 1902:22m).

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[30] See for example Rasmussen (1990b:131), summarizing his 1983 paper. Mayrhofer (1986:5.2.1.2) is also in favour of this hypothesis.

One might however consider the matter of the so-called schwa secundum, where an epenthetic vowel clearly is inserted to break up word-initial TTR- clusters (cf. Mayrhofer 1986:7.3.12). In this case, the Greek reflex seems to be /i/:

/ptnéh$_2$mi/ 'I spread' > Gr. _pítnēmi._
/k^{w}tru-/ 'four' > Lat. _quadra-,_ Gr. _písures._

But if the normal epenthetic vowel is /i/, it is unclear why */h$_1$/ plus epenthesis would develop into /e/, since */h$_1$/ does not colour /i/.

Deletion.

In restricted environments one sees cases where laryngeals disappear within PIE: Mayrhofer (1986:5.2.1.4.2-3, 5.2.2.8) discusses -CRHV- in posterior elements of compounds and in the reduplicating roots. Note how */n/ develops as a consonant in the following words, instead of syllabically, as it should between consonants:

*/(newo-)ǵnh$_1$o-/ 'neonate' > */-ǵno-/ > Gr. _neognós,_ Goth. _niuklahs_ (< _*-kna-ha-), ainakls_ (< _*-knaz_), Lat. _prīvi-gnus,_ Gaul. _Trutiknos,_ Av. _ā-zna_ 'innate', Phryg. _ouegnōi_ (< _*sue-gno_-) (Beekes 1988:60).
*/ǵi-ǵnh$_1$o-/ > */ǵi-ǵno-/ 'be born' > Gr. _gígnomai,_ Lat. gignere (Beekes 1988:61).

Mayrhofer (1986:5.2.1.2) says that /h$_1$/ exceptionally disappears preconsonantally at the head of compounds accented at the end:

*/h$_1$su-g^{w}ih$_3$ḗs/ > Gr. _hugiḗs._

Eichner (1988:133) claims Stang's Law reductions in accusative */-eh$_2$m/ (> */-ām/). These losses would seem to suggest that the laryngeals were quite weak, perhaps even glides. Stang's Law, in fact, normally affects only */w/.

In general, laryngeals as consonants disappear in the daughter languages. This would seem to be a phenomenon that recurred several times, with somewhat different conditions in the various daughter languages. In Anatolian, */h$_1$/ disappeared except perhaps initially before consonants. Elsewhere, laryngeals generally disappeared before vowels, with the possible exception of Armenian and Albanian. Initially before consonants, laryngeals generally disappear except in those languages where they survive as vowels. After vowels, they disappear with compensatory lengthening (see below). Between consonants, they generally surface as vowels, as already discussed.

But even when it is clear that laryngeals in the same position disappeared in two or more languages, it is often obvious that this must have followed other language-specific innovations, and is therefore a language-specific development. Laryngeals must have remained post-consonantally in Indo-Iranian long enough to block Brugmann's Law (Mayrhofer 1986:5.2.4.2-3):

o > ā / _ $]_\sigma$R
cakāra 's/he made' < */k^{w}ek^{w}ore/, but _cakara_ 'I made' < */k^{w}ek^{w}orh$_2$e/ (Ad Beekes 1988:64).

There is also the evidence mentioned above that some word-initial laryngeals may have lingered long enough to cause compensatory lengthening in compounds:

> */h$_2$nér-/ ‘man’ (Gr. *anḗr,* Armen. *ayr*, Phryg. *anar)*, with *su-* ‘good’: Ved. *sūnára-;* with OAvest. *kamna-* ‘few’: Avest. *kamnānar-* (Mayrhofer 1986:5.2.2.1).

There is a hypothesis that some Vedic and Gāthic hiatus is caused by intervocalic laryngeals (Beekes 1969:10, Mayrhofer 1986:5.2.4.4), and that some word-final long-short alternations were caused by final laryngeals (Beekes 1969:145-161):

> Indo-Iranian */-aHam/ *‘gen. pl.’* > Ved. *-aam* (Beekes 1988:64).

Similarly, laryngeals must have survived in Greek and Armenian long enough to account for the triple representation in “prothetic vowels”. The overwhelming evidence is that most of the deletions of laryngeals were independent daughter-language developments. This imposes a rather strong requirement that whatever values are proposed for the laryngeals must be segments that have a high probability of historical loss, such as glottals or fricatives. Note also that unless one is prepared to accept that epenthesis preceded deletion in most languages, the requirement is actually stronger: one should expect the sort of segment that has a high probability of loss adjacent to vowels, but vocalizing elsewhere. I know of no specific study of this deletion pattern, but semivowels seem a logical candidate.

Compensatory lengthening.

Perhaps the most important daughter-language development, the one which led to Saussure’s discovery of laryngeals in the first place, was that a post-vocalic laryngeal disappeared in most languages, with compensatory lengthening if tautosyllabic (Saussure 1879; Benveniste 1935:149):

> */meh$_1$nsos/ ‘month *(gen.)*’ > Gr. *mēnós* (Beekes 1988:73).
> */b^{h}oh$_2$neh$_2$-/ > Gr. *phōnḗ* ‘voice’ (Beekes 1988:73).
> Ad PIE */deh$_3$-/ ‘give’, Gr. *dídōmi,* Skt. *dádāti.*

Compensatory lengthening affected syllabified sonorants as well as true PIE vowels. */i/ and */u/ clearly lengthened to /ī/ and /ū/. The long liquids and nasals show up in many languages (Indo-Iranian, Italic, Celtic, Balto-Slavic, and, at least when unaccented, Greek) as a non-syllabic sonorant and adjacent long vowel, as if */R̥H/ were first restructured as */RH̥H/ (like Vedic svarabhakti?) . The Balto-Slavic forms are of the same quality as the reflexes of short sonorants, only acute (Watkins 1965:117). In other languages, such as Tocharian, Germanic, and Armenian, syllabic consonants developed the same regardless of whether an */H/ followed. The Sanskrit and Italic forms have a vowel component generally the same colour as the normal schwa reflex (except Sanskrit syllabic nasals, which go to /ā/) (Saussure 1879). So the long sonorants seem to give no further clue as to the timbre of the laryngeal. As was the case for Rix’s Law, however, one gets some more puzzling clues as to the relative sonority of the laryngeals and resonants.

> */plh$_1$no-/ > Skt. *pūrṇá-* ‘full’, OIr. *lán,* Goth. *fulls* (Beekes 1988:65, 94, 99).
> */ǵnh$_1$to-/ > Skt. *jātá-* ‘born’, Late Gath. *zāta-*, Lat. *(g)nātus,* Goth. *kunþs* (Beekes 1988:65, 70, 92).
> */ḱrh$_2$snh$_2$/ > Skt. *śīrṣā* ‘heads’ (Beekes 1988:62).
> */ǵnh$_3$-/ > Lith. *pa-žìnti* ‘know’ (Beekes 1988:89).

Lindeman (1987:§5) mentions the following cases of compensatory lengthening as typological evidence: /es/ > /ē/ in Greek *ēmí,* ‘I am’, Latin *aēnus* ‘copper’ < **ayesnos,* and English *daughter.* Lehmann (1952:14.4) cites many examples within IE to conclude that continuants are particularly likely to disappear with compensatory lengthening. Bomhard (1979:130-131, citing Couvreur) mentions the change VʔC > V̄C in Akkadian and some forms of Arabic. There seems to be little point in amassing such examples, however. If Hock (1991:89-92) is right, compensatory lengthening can be triggered by any deletion of a (mora-bearing) coda, so the process per se does not reveal too much about the nature of the disappearing segment: we only know that if we could identify other contemporaneous coda-deletions that did not result in compensatory lengthening, then the laryngeals would have to be more sonorous than those segments. In the absence of such data, we have only a very weak inclination to posit a somewhat sonorous quality to the laryngeals.

Indo-Iranian aspiration.

In Indo-Iranian,[31] */h$_2$/, but no other laryngeal, turns a preceding oral stop into an aspirate without changing its voice (Kuryłowicz 1927c, Hoenigswald 1965, Mayrhofer 1986:5.2.2.3):

*/pnth$_2$ós/ 'path *(gen.)*' > Skt. *pathás,* Gath. *paθah* (Beekes 1988:63, 68).
*/meǵh$_2$ós/ 'big' > _*maǵ^{h}ás_ > *maháḥ* (Mayrhofer 1986:5.2.2.3.1).

Beekes seems intent on demonstrating that */h$_1$/ could have this effect too (1969:180; 1989), but his arguments depend on misidentifying several */h$_2$/ as */h$_1$/.

This evidence strongly suggests that */h$_2$/ was a glottal continuant at the time of the change. Since it did not change the voice of the preceding obstruent, it would seem not to have been an obstruent itself. A likely contender therefore is /h/ or /ɦ/.

On the other hand, when the */h$_2$/ appeared between consonants, one generally got both aspiration and a vocalic reflex, at least within Old Indic:

*/d^{h}ugh$_2$tér-/ 'daughter' > Ved. *duhitár-,* Old Avest. *dugədar-* < */d^{h}ug^{h}tér-/ (Mayrhofer 1986:5.2.2.3.2B).

The simplest explanation would seem to be that Indic first had /i/ epenthesis, then lost */h$_1$/ and */h$_3$/, then suffered aspiration at the hands of */h$_2$/. Otherwise one must assume that only */h$_2$/ had some special property to cause aspiration and that it remained intact after doing so, so as to be subject to a later rule replacing all laryngeals with /i/.

Other evidence.

One potentially lucrative mine of evidence for the phonological nature of the PIE laryngeals could be the nature of the counterparts within languages related to PIE. Indeed, some of the earliest work in reconstructing the laryngeals was done by Møller, who tried to demonstrate the genetic relationship between the two language families, and ended up reconstructing laryngeals corresponding in value to the Semitic glottals and pharyngeals. More recently, Čop (1970) explores the nature of laryngeals within the context of a theory hypothesizing a common origin between Indo-European and Uralic. The Nostraticists bring in far-reaching data to conclude (Shevoroshkin 1988) that */h$_1$/ is from /ʔ/, /ħ/, or /ʕ/ (glottals and pharyngeals) and /h$_2$/ is from /q/, /ɢ/, /χ/, or /ʁ/ (uvulars). Unfortunately it must be concluded that at this point, when the very fact of genetic relationship is in question and regular sound changes are by no means well established, looking at sister languages would be a totally fruitless exercise.

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[31] Greppin (1988:186-8) rejects the idea that Armenian aspirates have a laryngeal origin.

Of somewhat greater promise is the study of very early loans. If one could demonstrate that early IE words containing laryngeals were borrowed into another language with a consistent value for the laryngeals, this could be a clue as to the laryngeals' value. Čop for example does this with putative loans into Uralic, where he concludes that they turn up as */k/ or */ɣ/ when in medial position, which argues for some sort of [+back] value for the original PIE forms. Koivulehto (1991), working mostly in Finno-Ugric, lists about two dozen possible borrowings, where he concludes that laryngeals show up as *x* (the more recent reconstruction for the segment earlier reconstructed as *ɣ), k,* or *š* medially, and *k* or zero initially (where *x* is not a permitted sound). The threefold medial representation appears to have nothing to do with the number of laryngeals, but is mostly a matter of chronology, with *x* claimed to be the oldest reflex. If this research is accepted, it constitutes evidence that the reflexes of the PIE laryngeals in the Germanic/Balto-Slavic region at one time were approximately velar or laryngeal sounds *(š* is a common enough development of original *x:* Hock 1991:131).

Of similar benefit would be consistent evidence that some PIE words containing laryngeals were borrowed from other languages. I know of no substantive work in this area.

Synthesis.

The data concerning sonority is decidedly contradictory. Obstruent Voice Assimilation shows that */h_1/ and */h_2/ are more sonorous than */s/ (probably sonorants), and there is some meagre evidence that */h_3/ was a voiced obstruent (viz., less sonorous than nasals). The syllabication rules indicate that they were all less sonorous than nasals. Root structure constraints indicates they were all roughly equal to */s/ in sonority and that all known types of stops are ruled out, i.e., they must be fricatives. Bartholomae's Law further rules out voiced aspirate stops. Metathesis points especially to liquids or glides, but does not rule out fricatives. Deletability suggests relative weakness, such as one might associate with approximants (glides) or even fricatives, but not stops or resonants. The strong Anatolian evidence, and much weaker evidence from other languages, suggests that */h_2/ at least was a voiceless fricative, and stronger than the other laryngeals. Other daughter-language developments point to weaker, even vocalic representations. The parent segments must have been such as to have had a very high likelihood of loss, since the loss occurred separately in several different languages. Finally, Indo-Iranian aspiration suggests that */h_2/ developed into a glottal fricative, which suggests that it was earlier a continuant.

There are several possible ways out of this dilemma. One possibility is a diachronic solution, that the laryngeals were once obstruents, but became sonorants later, but still before the language broke up. This might explain the obstruent-like behaviour in the root template, since inherited vocabulary could well be phonotactically conservative, but it would be surprising if the cyclical syllabification continued to act as if the laryngeals were obstruents well after they turned into sonorants.

Another possibility is to reconstruct some complex segment structure that would explain ambiguous sonority. The literature gives a few tantalizing clues as to what kind of segments might have a sonority intermediate between nasals and most obstruents. The aforementioned evidence of the Kwakw'ala glottalized sonorants suggests that the laryngeals might be sonorants with secondary articulations making them less sonorous.

For example, if the laryngeals were glottalized liquids, they might have had obstruent behaviour in some contexts, but liquid behaviour in others. This is almost attractive: an ejective retroflex /ɽ’/ would even be expected to have /a/-timbre, and an ejective velarized /ɫ’/ would have /o/-timbre. Unfortunately, this is typologically quite unnatural for PIE unless one accepts the glottalic hypothesis, and the consonantal daughter-language developments seem far removed. There is also indication that something as simple as voicing may add sonority. Zec mentions that in Danish, /ð/ patterns with the sonorants in being able to bear the stød (Zec 1988:24), and in Serbo-Croatian, /v/ patterns with the sonorants in being moraic (p. 145). This is made explicit in Jespersen’s sonority scale, where voiced fricatives—which are (otherwise) unknown in PIE—are held to be more sonorous than other obstruents (Jespersen 1904:186). Selkirk (1984:112) also has voiced obstruents being more sonorous than voiceless obstruents of the same [cont] value. But others deny that voicing has anything to do with sonority (Kiparsky 1979:432), and the facts in this case are contrary: the one laryngeal for which there may be direct evidence for voice, */h_3/, is the one laryngeal for which there is evidence of lesser sonority (causing obstruent voice assimilation). It is also awkward to assume it is a voiced obstruent, since its vowel colour indicates it is not the voiced counterpart of any other sound, and obstruents rarely voice non-contrastively.

Finally, one might hypothesize segments in places of articulation for which sonority effects are ambiguous. The glottal and pharyngeal areas are just the ticket here. Many consider these to be universally glides (Halle, cited by Clements 1990b:38n17), and phonetically they certainly are very vocoid, having little or no buccal frication. Keiler (1970) for example repeatedly stresses their vocoid nature, and several examples already given have shown pharyngeals being pronounced like vowels or developing directly into vowels. Yet they often pattern as obstruents. Glottal fricatives are usually voiceless, even though glides are normally voiced. In the Semitic languages, pharyngeals look very much like other obstruents, and regularly come in voiced/unvoiced pairs; they share none of the deletion and monophthongization that the glides /y/ and /w/ are heir to. Of the two articulations, the pharyngeal seems the most likely. The Anatolian data, particularly the alphabetic inscriptions and Greek transcriptions, could easily be attempts to represent pharyngeals, or dorsal fricatives, which have been known to develop from pharyngeals (e.g., Standard Israeli Hebrew /x/ from earlier /ħ/), but are unlikely to be developments from forms of /h/. It is also easy to see how voiced pharyngeal continuants could develop into vowels, especially in view of the Shuswap data. But glottal /h/ is very unlikely to have become voiced in all positions in several different languages, so vocalization could have happened only if the laryngeals had all started as forms of /ɦ/, and even then I know of no comparative examples.

Discussion of sonority or strength is not quite finished. It has been noted that */h_1/ is weaker that the other laryngeals, since it was lost or turned into a vowel in all languages, whereas */h_2/ and to a lesser extent */h_3/ survived as consonants in Anatolian and perhaps Albanian and Armenian. Thus we would expect an approximate ordering */h_2/ > */h_3/ > */h_1/ on a diachronic weakening hierarchy such as that of Hock (1991:83). For consonants that are all pharyngeal, strength may be related to secondary articulation. For example, it appears that pharyngeals have a tendency to attract [+low] and [+back] articulation. If we assume that these features reinforce the pharyngeal either articulatorily (by pressing against the pharyngeal wall) or acoustically (by making the sound more salient by producing a larger oral cavity), then they might contribute to its survival. So */h_2/ may be hypothesized to have two of these features, or the stronger of the two; */h_3/ to have just one, perhaps the weaker one; and */h_1/ none at all. Fortunately this corresponds directly to known facts about vowel colouring and vocalic developments in the triple representation: *a*-colouring */h_2/ was [+low, +back], *o*-colouring */h_3/ was [–low, +back], and non-colouring */h_1/ was [–low, –back].

The [voice] of the laryngeals is no clearer than their other features. The internal PIE evidence shows that */h_1/ and */h_2/ are underspecified for [voice], since they do not participate in the general process of Obstruent Voice Assimilation. This would seem to indicate they were voiced, since sonorants are usually voiced in the unmarked state, but pharyngeals may be different: the Northwest Caucasian languages in general have only a voiceless pharyngeal (Colarusso 1988), although Shuswap has only voiced ones. The fact that the pharyngeals developed into vowels in Greek and Armenian, and indeed, in my estimation, in most languages, would also suggest that they started life voiced. On the other hand, what consonantal reflexes have been discovered have all been voiceless, for */h_2/ at least (Anatolian back voiceless continuant; /k/; Armenian, Albanian /h/); */h_1/ disappeared too consistently to say one way or the other, although one notes that even in Anatolian it occasionally turns up as a vowel, e.g., word-initially. There is also the issue as to whether */h_3/ really causes obstruent voice assimilation. There is meagre evidence that */h_3/ voiced preceding consonants in PIE, and a few hints that in Anatolian it may have been the voiced member of a pair with the reflex of */h_2/. These facts may support each other; on the other hand, the Anatolian data may simply reflect the weaker strength of */h_3/, and therefore its tendency to lenite. If */h_3/ does cause voicing assimilation, then it must be voiced itself. But it is unclear why only */h_3/ should cause voice assimilation. One guess would be that its [+back] feature makes it the only pharyngeal sound with the tongue acting as an oral articulator: since the tongue is actually approaching the uvular region, it may have added enough oral frication to cause */h_3/ to pattern like an obstruent with respect to this rule.

In the absence of any historical survey as to whether pharyngeals tend to voice or devoice over time, I judge that the preponderance of data suggests that they were all voiced in PIE. The only certain counterevidence is the Anatolian, where */h_2/ patterns with the PIE tenues and so indicates voicelessness, and a spontaneous strengthening in Anatolian seems at least as likely as a series of unrelated lenitions elsewhere.

The suggestion therefore is that the three laryngeals were [+CP +son +voice +cont] segments (i.e., */ʕ/) differentiated by their dorsal coarticulation. */h_1/ had a [–high –back –low] coarticulation, perhaps with [+ant], resulting in a segment that could be characterized as */ʕ^{ə}/ or */ʕ^{e}/. */h_2/ had a [–high +back +low] coarticulation that might be represented as */ʕ^{a}/. */h_3/ had a [–high +back –low +round] coarticulation that could be represented by */ʕ^{o}/. Although this suggestion may seem a little unfamiliar, it has certain typological felicities. It will be recognized as being very much like the trio of pharyngeal glides Kuipers described for Shuswap, and so is definitely a possible set of phones. Moreover, it can be shown to be easily derivable from sources that are structurally well-balanced for PIE. They may have started out as the fricatives corresponding to the dorsal series, as in Cowgill's conjecture mentioned earlier, i.e., */x́, x, x^{w}/. This is nice because PIE has palatal, velar, and labiovelar obstruents for tenues, mediae, and aspiratae; this fills out the pattern with fricatives analogous to the /s/ in the dental series (although there still remains the lack of a labial fricative). The surmisal is that a sound change operating on all dorsal fricatives replaced the buccal frication with pharyngeal: i.e., [–son] became [+CP +son] in the context of [+Dorsal +cont]. [+voice] followed as a redundant feature of [+son]. This results in a series */ʕ^{y}/, */ʕ^{ɰ}/, */ʕ^{w}/. Note that the general oral configuration does not change, but the degree of constriction is relaxed somewhat, replaced by pharyngeal friction. In a possibly concurrent change, the preference of the pharyngeals for low tongue height lowers the tongue to the lowest position that the language normally permits for the frontness and rounding cofeatures.

This may be thought of as two phonological rules: [+high] becomes [–high] in the context of [+CP] (which gives */ʕ^{e}/, */ʕ^{ɣ}/, */ʕ^{o}/), then [–low] becomes [+low] in the context of [+back –round], which lowers */h_2/ further to */ʕ^{a}/.

Extending the history into the daughter languages, it is noteworthy that the segments can be looked at it two ways: they are at the same time pharyngeal continuant consonants with a dorsal coarticulation, and they are vowels reduced to pharyngealized glides. */h_1/, lacking any [+back] or [+low] feature to reinforce it, may have already lost its pharyngealization in PIE times, becoming a simple glottal */ɦ^{e}/, especially liable to loss, as all glottals are. In Anatolian, */ʕ^{a}/ was subject to a strengthening: it became fortis. */ɦ^{e}/ probably lost its colouring and picked up the default [+low] marking of glottals: */ɦ^{a}/, but generally was lost adjacent to a vowel, otherwise becoming /a/. */ʕ^{o}/ may have stayed pretty much the same, perhaps losing its roundness. For practical purposes the Anatolian triad was then —, /ħ/, /ʕ/, with no particular coloration in evidence. It is possible that these last two were further strengthened with buccal articulation. This happened to /ħ/ in modern Hebrew, and Bomhard (1984) cites Colarusso (1981:545-546) as reporting a similar development in several Northwest Caucasian languages, via a pharyngealized velar; but this step is not strictly required by the evidence, since the graphemes used in Anatolian are incapable of making distinctions among postpalatal continuants, and the velars found in the Greek transcriptions have been known to be used to represent pharyngeals (cf. *Gómorrha* for *ʕamōrā,* 'Gomorrah').

In Greek, the vocalic qualities of the segments predominated. Perhaps an early step was the loss of pharyngealization ([CP]), which left segments like */ɦ^{e}/, */ɦ^{a}/, */ɦ^{o}/, or perhaps rather */e̯/, */a̯/, */o̯/. The Greek penchant for unsyllabicizing PIE resonants next to a laryngeal is simply a recognition that these sounds now have higher sonority than the resonants when it comes time to apply synchronic syllabification rules. It is also clear that as glides, these would normally disappear next to a full vowel (as glides generally did in Attic), with compensatory lengthening if lost from a coda. Otherwise, they were syllabified as full vowels.

In Indo-Iranian, it seems the consonantal interpretation had the upper hand. The /i/ reflex has the hallmarks of a genuine epenthetic vowel, inserted whenever the laryngeals made difficult clusters. Later, the weaker */h_1/ and */h_3/ disappeared, but */h_2/ remained around, reduced to some sort of glottal, long enough to cause aspiration.

In other lands, where the main residues of laryngeals are interconsonantal schwas and compensatory lengthening, it appears likely that the laryngeals collapsed into a single segment, perhaps eventually becoming */ɦ^{a}/, with the low colouring preferred by glottals. It probably became vocalic interconsonantally but remained consonantal (perhaps */h/) in other positions, where it was eventually lost.

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